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(71) Applicant: **HITACHI, LTD.**
6, Kanda Surugadai 4-chome Chiyoda-ku
Tokyo 100(JP)

(72) Inventor: **Tatsuno, Kimio**
14-6, Nishikoigakubo-4-chome
Kokubunji-shi(JP)

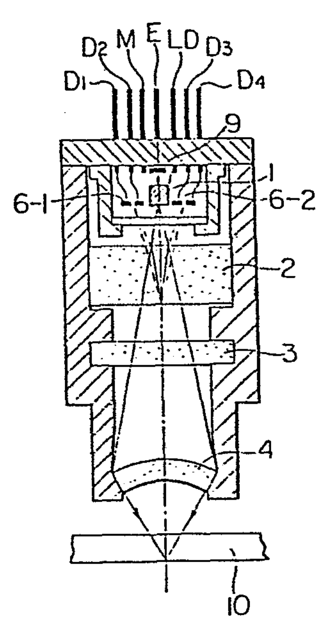
(72) Inventor: **Kataoka, Keiji**
728-19, Imafuku
Kawagoe-shi(JP)

(74) Representative: **Patentanwälte Beetz sen. - Beetz jun.**
Timpe - Siegfried - Schmitt-Fumian
Steinsdorfstrasse 10
D-8000 München 22(DE)

(54) **Optical head.**

(57) This invention is characterized in that a modified polarization prism (2) or a modified half prism (8) is used therein. Since photodetectors (6-1, 6-2) serving at the same time for light signal detection, for automatic focussing and for tracking are disposed at both the sides of said optical source (1) of a semiconductor laser, a single axis optical system can be realized and it is possible to reduce the optical head in size.

FIG. 1



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Croydon Printing Company Ltd

OPTICAL HEAD

This invention relates to an optical head, which is suitable for recording and play-back for so-called optical disc, digital audio disc, video disc, etc.

A conventional recording and play-back head for the optical disc is so large as it amounts to 40 x 40 x 30 mm³ even for that utilized in practice and heavy, that it prevents to reduce the volume and the weight of a whole optical disc device or to realize mass storage stacked optical discs. As one of the reasons therefor it is pointed out that it is difficult to realize a single axis optical system, because the light beam reflected by an optical disc is bended by means of a half prism or a polarization prism so that its optical axis is deviated by 90°, and detected by using a photodetector disposed therebehind.

In order to resolve this problem, a small type optical head has been proposed since several years, of which head utilizes the effect that oscillation output is increased by the self coupling effect, when light is returned to the light emitting part of a semiconductor laser optical source, so-called SCOOP effect.

However, it is pointed out that the self coupling effect is a sort of instability of the oscillation phenomena of a semiconductor laser, and at present, for digital audio discs, video discs, etc., which have been commercialized since recent one or two years, to the contrary, techniques for suppressing this effect as noise entering play-back signals or positioning signals are developed. The self coupling effect for the semiconductor laser is an effect which can be observed in a structure of a resonator consisting of three mirrors, i.e. a reflecting surface of the optical disc added to two proper mirrors of the resonator in the semiconductor laser. Thus, due to fluctuations in the direction of the optical axis provoked by the rotation of the optical disc, the distance between the semiconductor laser and the optical disc fluctuates within a range of about 1 μm and consequently the semiconductor laser has a resonator structure whose stability is very bad. Consequently, there are too many problems to be resolved to reproduce signals on the optical disc by using the SCOOP effect.

The object of this invention is to provide an optical head permitting to remove the drawbacks mentioned above, accompanying the reduction of the optical head in size, and to realize a small type optical head.

That is, in an optical head according to this invention, photodetectors for automatic focussing or tracking are disposed in hybrid or in monolithic manner just beside a semiconductor laser optical source and reflected signal light coming from an optical disc is guided by a polarization prism and a 1/4 wave plate or only by a half prism to said photodetectors.

The present invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a cross-sectional view showing an example of optical heads according to this invention;

Figs. 2A and 2B are a plan view and a cross-sectional view, respectively, in a larger scale, of the prism portion, the optical source portion and the photo-detector portion indicated in Fig. 1;

Fig. 3 is a schematic view showing another example of this invention; and

Fig. 4 is a perspective view of the prism portion used in an optical head according to this invention.

Fig. 1 shows an application example of an optical head according to this invention to the play-back for a digital audio disc, a video disc, etc. or to the recording and play-back for a DRAW (Direct Read After Write) disc. The optical disc play-back head should fulfil the conditions that when the disc fluctuates in the vertical direction, the collected beam is always well focussed in a spot on the disc and that when the track moves due to the excentricity of the disc, the spot of the collected beam follows always the track. Hereinbelow the method for detecting the automatic focus and for tracking will be described in detail.

A light beam leaving a semiconductor laser chip 1 passes through a modified polarization prism 2 via a window. The modified polarization prism 2 is the key element of this invention. The element has two polarizing reflecting surfaces 5, which are symmetric with respect to a plane including the optical axis. The polarizing reflecting surfaces 5 are disposed within a region near the optical axis. Consequently light beams thus divided are reflected at the polarizing reflecting surfaces 5 with an acute angle smaller than 45° and reach photodetectors 6-1, 6-2 disposed at both the sides of the semiconductor laser 1. Fig. 4 shows the outline of the modified polarization prism. The beam coming from the semiconductor laser 1 enters the prism 2 as a p-polarized beam and passes therethrough with a transmission coefficient greater than 99%. Thereafter the beam is transformed into a circular polarized beam through a 1/4 wave plate and forms a spot defining the diffraction limit on an optical disc 10, which is an information recording medium, with the aid of a microlens 4. An aspheric lens, a GRIN (Gradient Refrative Index) lens, a hologram lens and the like can be used effectively as a microlens 4. For example, a spheric hologram lens is useful, because it can reduce remarkably aberration. Light reflected by the disc 10 returns to the microlens 4 and a circular polarized beam is transformed into an s-polarized beam, by passing again through the 1/4 wave plate, which enters the modified polarization prism 2. At this moment, as indicated in Fig. 2, the s-polarized incident beam is reflected to both the sides symmetrically with respect to the plane including the optical axis and the two beams thus reflected are collected as spots, each in the form of an ellipse, on two pairs of photodetectors 6-1 and

6-2, respectively, which are disposed at both the sides of the semiconductor laser chip 1. The photodetectors 6-1 and 6-2 consist of two photosensitive elements D_1, D_2 and D_3, D_4, respectively. Since light intensity detected by each of the photosensitive elements varies differently with fluctuations of the optical disc in the vertical direction (defocus), differential signals obtained by the two photosensitive elements can be used as detection signals for focus shifts. The photodetectors 6-1 and 6-2, each of them being divided into 2, are so adjusted that a conjugate image of the spot on the disc is formed on each of the dividing lines, when the incident light beam is well focussed on the optical disc. When the disc shifts in such a direction that it becomes more distant from the lens, the conjugate points shift from the photo-detectors toward the prism 2. At this time, since the light beams entering the center of the prism remain unchanged, the conjugate points move along these light beams. Taking this fact into account, it is understood that light intensity on the outer photosensitive elements D_1 and D_4 of the photodetectors divided into 2 increases and this gives rise to difference signals. To the contrary, when the disc shifts in such a direction that it becomes closer to the lens, the conjugate point shift in such direction that it becomes more distant from the prism. In this case, light intensity on the inner photosensitive elements D_2 and D_3 of the photodetectors divided into 2 increases and this gives rise to difference signals.

According to this principle mentioned above, denoting the light detection output voltage of the photosensitive elements D_1, D_2, D_3 and D_4 by $V(D_1)$, $V(D_2)$, $V(D_3)$ and $V(D_4)$, respectively, the focussing error signal AF can be represented for example by

$$AF = V(D_1) + V(D_4) - (V(D_2) + V(D_3)),$$

and thus it is possible to know the direction and the magnitude of the shift of the disc.

On the other hand, when the spot of the collected beam deviates from the position of the track, this gives rise to unbalance in light intensity distribution. The tracking shift signals can be obtained by utilizing this unbalance. That is, since the intensity ratio of the two beams, into which the returning beam is divided by the prism 2, varies, the output signals of the photodetectors 6-1 and 6-2 disposed at both the sides of the semiconductor laser 1 are different from each other.

Consequently the tracking signal TR can be obtained for example by

$$TR = V(D_1) + V(D_2) - (V(D_3) + V(D_4)).$$

The direction of the tracking shift can be also determined, depending on whether this difference signal is positive or negative.

Finally the signal on the disc is detected by the total sum $(V(D_1) + V(D_2) + V(D_3) + V(D_4))$ of light intensity entering the photodetectors 6-1 and 6-2.

In addition, a reference numeral 9 in Fig. 1 represents a photodetector for monitoring, which receives backward output light of the semiconductor laser 1, and the output of this detector can be utilized for output adjustment of the semiconductor laser 1.

Since the play-back optical system explained above uses a polarization prism and a 1/4 wave plate, it has a high light utilization rate and can serve as an optical head for recording.

Fig. 3 illustrates an application of this invention to an optical head for play-back. In this embodiment the modified polarization prism is replaced by a modified half prism having the same structure as the modified polarization prism and the 1/4 wave plate is removed.

The method for automatic focussing and that for tracking are the same as those stated previously. The modified half prism 8 includes reflecting surfaces 7 having a transmission coefficient of 50%. For this optical head, although the light utilization rate is reduced to 1/4 with respect to that for recording, since the polarizing property of the reflecting surfaces in the prims and also the 1/4 wave plate are not needed, it is possible to realize a very cheap small type optical head.

As explained above, according to this invention, only a prims and a microlens are used as optical parts and thus it is possible to reduce remarkably the number of parts used in an optical head, which heretofore have amounted to a considerable number. Furthermore it is also possible to realize an optical head with a high reliability, which is suitable to mass production, by forming a semiconductor laser and photodetectors in hybrid in a common package.

In addition, it is possible to realize an optical head without utilizing the so-called SCOOP effect, which has the same size as that using the SCOOP effect and to reduce the size of the optical head, which heretofore has been a neck for reduction in size of an optical disc device as a whole or for a mass storage stacked optical disc device.

CLAIMS:

1. An optical head comprising:

an optical source of a semiconductor laser (1);

an optical system (4) collecting a laser beam emitted by said optical source (1) focussing a spot on a recording medium (10);

photodetectors (6-1, 6-2) disposed at both the sides of said optical source (1); and

a beam dividing element (2 or 8) disposed between said optical source (1) and said optical system (4) and dividing light reflected by said recording medium (10) into two so as to lead them to said photodetectors (6-1, 6-2), respectively.

2. An optical head according to Claim 1, wherein said beam dividing element is a half prism (8) having reflecting surfaces (7) disposed symmetrically with respect to a plane including the optical axis, of which surfaces are comprised in a region near said optical axis.

3. An optical head according to Claim 1, wherein a 1/4 wave plate (3) is disposed between said beam dividing element and said optical system (4) and said beam dividing element is a polarization prism (2), having reflecting surfaces (5) disposed symmetrically with respect to a plane including the optical axis, of which surfaces are comprised in a region near said optical axis.

4. An optical head according to Claim 1, wherein said optical system (4) comprises an aspheric lens.

5. An optical head according to Claim 1, wherein

said optical system (4) comprises a GRIN lens.

6. An optical head according to Claim 1, wherein said optical system (4) comprises a hologram lens.

7. An optical head according to Claim 1, wherein each of the photodetectors (6-1, 6-2) disposed at both the sides of said optical source (1) comprises 2 photo-sensitive elements (D_1, D_2 and D_3, D_4).

8. An optical head according to Claim 1, wherein the photodetectors (6-1, 6-2) are formed in hybrid or in monolithic manner together with said semiconductor laser (1).

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FIG. 1

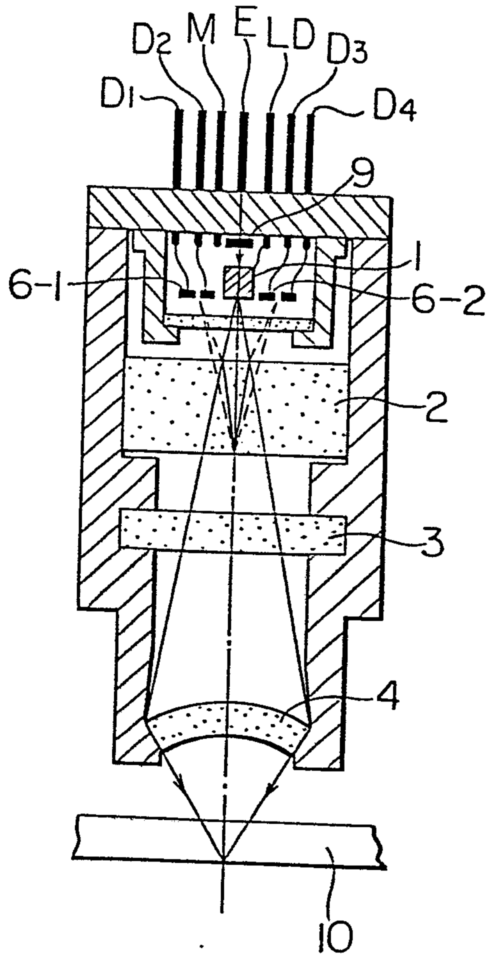
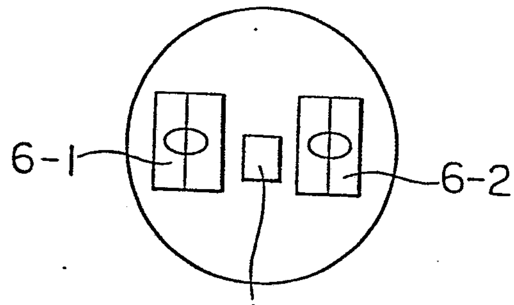


FIG. 2A



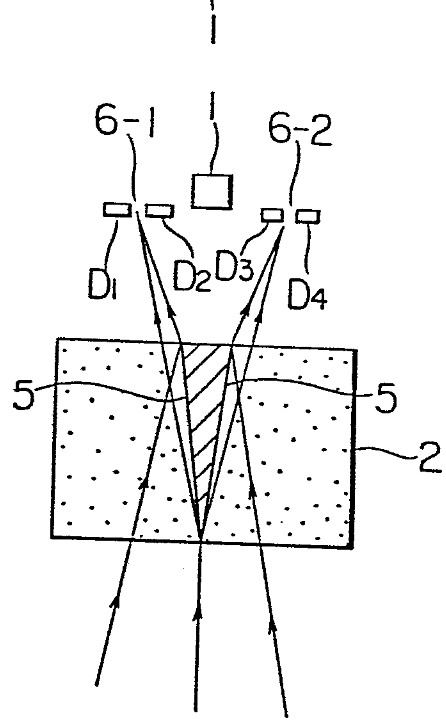


FIG. 2B

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FIG. 3

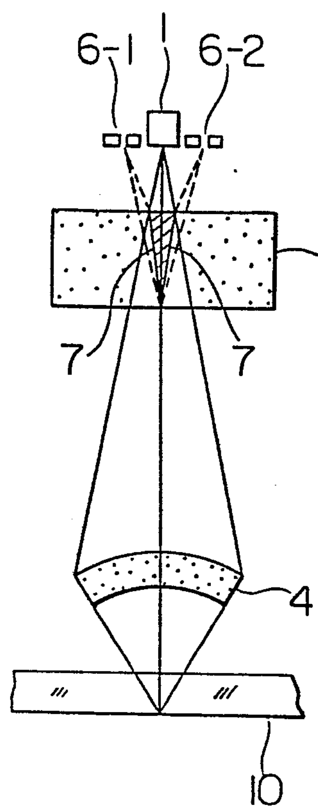

FIG. 4